

**What is claimed is:**

- 1        1. A high-speed low-noise charge pump comprising:  
2        an output node;  
3        a first cascode current mirror coupled to a first  
4                reference current source and adapted to generate  
5                a first mirror current, including a first output  
6                mirror transistor and a first output cascode  
7                transistor;  
8        a second cascode current mirror coupled to a second  
9                reference current source and adapted to generate  
10               a second mirror current, including a second  
11               output mirror transistor and a second output  
12               cascode transistor coupled to the first output  
13               cascode transistor at the output node;  
14        a first switching transistor being turned on during  
15               assertion of a first control signal to cause the  
16               first mirror current to flow through the output  
17               node, having a gate, a source and a drain where  
18               the source of the first switching transistor is  
19               coupled to the first output mirror transistor,  
20               the drain of the first switching transistor is  
21               coupled to the first output cascode transistor,  
22               and the gate of the first switching transistor  
23               receives the first control signal; and  
24        a second switching transistor being turned on during  
25               assertion of a second control signal to cause the  
26               second mirror current to flow through the output  
27               node, having a gate, a source and a drain where  
28               the source of the second switching transistor is

29 coupled to the second output mirror transistor,  
30 the drain of the second switching transistor is  
31 coupled to the second output cascode transistor,  
32 and the gate of the second switching transistor  
33 receives the second control signal.

1 2. The charge pump as recited in claim 1 wherein:  
2 the first output mirror, the first output cascode and  
3 the first switching transistors are n-channel MOS  
4 transistors; and  
5 the second output mirror, the second output cascode,  
6 and the second switching transistors are p-  
7 channel MOS transistors.

1 3. The charge pump as recited in claim 2 wherein:  
2 the first output mirror transistor has a drain coupled  
3 to the source of the first switching transistor  
4 and a source coupled to ground;  
5 the first output cascode transistor has a source  
6 coupled to the drain of the first switching  
7 transistor and a drain coupled to the output  
8 node;  
9 the second output mirror transistor has a drain coupled  
10 to the source of the second switching transistor  
11 and a source coupled to a voltage supply; and  
12 the second output cascode transistor has a source  
13 coupled to the drain of the second switching  
14 transistor and a drain coupled to the first  
15 output cascode transistor at the output node.

1       4. The charge pump as recited in claim 1 wherein the  
2 first and the second cascode current mirrors are a wide-  
3 swing cascode current mirror.

1       5. The charge pump as recited in claim 4 wherein:  
2 the first cascode current mirror further comprises:  
3       a first input mirror transistor coupled between  
4       the first output mirror transistor and  
5       ground; and  
6       a first input cascode transistor coupled between  
7       the first output cascode transistor and the  
8       first reference current source;  
9 the second cascode current mirror further comprises:  
10       a second input mirror transistor coupled between  
11       the second output mirror transistor and a  
12       voltage supply; and  
13       a second input cascode transistor coupled between  
14       the second output cascode transistor and the  
15       second reference current source.

1       6. The charge pump as recited in claim 5 wherein:  
2 the first input mirror and the first input cascode  
3 transistors are n-channel MOS transistors; and  
4 the second input mirror and the second input cascode  
5 transistors are p-channel MOS transistors.

1       7. The charge pump as recited in claim 6 wherein:  
2 the first input mirror transistor has a gate coupled to  
3 the first output mirror transistor and a source  
4 coupled to the ground;

5       the first input cascode transistor has a gate coupled  
6           to the first output cascode transistor and a  
7           drain coupled to the gate of the first input  
8           mirror transistor and the first reference current  
9           source;  
10       the second input mirror transistor has a gate coupled  
11           to the second output mirror transistor and a  
12           source coupled to the voltage supply; and  
13       the second input cascode transistor has a gate coupled  
14           to the second output cascode transistor and a  
15           drain coupled to the gate of the second input  
16           mirror transistor and the second reference  
17           current source.

1       8. A high-speed low-noise charge pump comprising:  
2       an output node;  
3       a reference current source providing a supply current;  
4       a first cascode current mirror coupled to the reference  
5           current source and adapted to generate a first  
6           mirror current from the supply current, including  
7           a first output mirror transistor and a first  
8           output cascode transistor;  
9       a second cascode current mirror coupled to the  
10           reference current source and adapted to generate  
11           a second mirror current from the supply current,  
12           including a second output mirror transistor and a  
13           second output cascode transistor coupled to the  
14           first output cascode transistor at the output  
15           node;

16       a first switching transistor interposed between the  
17           first output mirror and the first output cascode  
18           transistors, being turned on during assertion of  
19           a first control signal to cause the first mirror  
20           current to flow through the output node; and  
21       a second switching transistor interposed between the  
22           second output mirror and the second output  
23           cascode transistors, being turned on during  
24           assertion of a second control signal to cause the  
25           second mirror current to flow through the output  
26           node.

1       9. The charge pump as recited in claim 8 wherein:  
2       the first switching transistor has a gate, a source and  
3           a drain, where the source of the first switching  
4           transistor is coupled to the first output mirror  
5           transistor, the drain of the first switching  
6           transistor is coupled to the first output cascode  
7           transistor, and the gate of the first switching  
8           transistor receives the first control signal; and  
9       the second switching transistor has a gate, a source  
10           and a drain, where the source of the second  
11           switching transistor is coupled to the second  
12           output mirror transistor, the drain of the second  
13           switching transistor is coupled to the second  
14           output cascode transistor, and the gate of the  
15           second switching transistor receives the second  
16           control signal.

1       10. The charge pump as recited in claim 9 wherein:

2       the first output mirror, the first output cascode and  
3             the first switching transistors are n-channel MOS  
4             transistors; and  
5       the second output mirror, the second output cascode,  
6             and the second switching transistors are p-  
7             channel MOS transistors.

1       11. The charge pump as recited in claim 10 wherein:  
2       the first output mirror transistor has a drain coupled  
3             to the source of the first switching transistor  
4             and a source coupled to a first voltage supply;  
5       the first output cascode transistor has a source  
6             coupled to the drain of the first switching  
7             transistor and a drain coupled to the output  
8             node;  
9       the second output mirror transistor has a drain coupled  
10            to the source of the second switching transistor  
11            and a source coupled to a second voltage supply;  
12            and  
13       the second output cascode transistor has a source  
14            coupled to the drain of the second switching  
15            transistor and a drain coupled to the first  
16            output cascode transistor at the output node.

1       12. The charge pump as recited in claim 9 wherein the  
2       first and the second cascode current mirrors are a wide-  
3       swing cascode current mirror.

1       13. The charge pump as recited in claim 12 wherein:  
2       the first cascode current mirror further comprises:

3           a first input mirror transistor coupled between  
4           the first output mirror transistor and a  
5           first voltage supply; and  
6           a first input cascode transistor coupled between  
7           the first output cascode transistor and the  
8           first reference current source;  
9       the second cascode current mirror further comprises:  
10          a second input mirror transistor coupled between  
11          the second output mirror transistor and a  
12          second voltage supply; and  
13          a second input cascode transistor coupled between  
14          the second output cascode transistor and the  
15          second reference current source.

1       14. The charge pump as recited in claim 13 wherein:  
2       the first input mirror and the first input cascode  
3       transistors are n-channel MOS transistors; and  
4       the second input mirror and the second input cascode  
5       transistors are p-channel MOS transistors.

1       15. The charge pump as recited in claim 14 wherein:  
2       the first input mirror transistor has a gate coupled to  
3       the first output mirror transistor and a source  
4       coupled to the first voltage supply;  
5       the first input cascode transistor has a gate coupled  
6       to the first output cascode transistor and a  
7       drain coupled to the gate of the first input  
8       mirror transistor and the first reference current  
9       source;

10       the second input mirror transistor has a gate coupled  
11           to the second output mirror transistor and a  
12           source coupled to the second voltage supply; and  
13       the second input cascode transistor has a gate coupled  
14           to the second output cascode transistor and a  
15           drain coupled to the gate of the second input  
16           mirror transistor and the second reference  
17           current source.

1       16. A high-speed low-noise charge pump having an output  
2       node, comprising:  
3       a first cascode current mirror coupled to a reference  
4           current source, including a first output mirror  
5           transistor and a first output cascode transistor,  
6           for generating a first mirror current;  
7       a first switching transistor receiving a first control  
8           signal and interposed between the first output  
9           mirror and the first output cascode transistors,  
10           for causing the first mirror current to flow  
11           through the output node when the first control  
12           signal is asserted;  
13       a second cascode current mirror coupled to the first  
14           cascode current mirror at the output node, for  
15           generating a second mirror current; and  
16       a second switching transistor receiving a second  
17           control signal, for causing the second mirror  
18           current to flow through the output node when the  
19           second control signal is asserted.

1       17. The charge pump as recited in claim 16 wherein the  
2       first switching transistor has a gate, a source and a drain,



3 where the source of the first switching transistor is  
4 coupled to the first output mirror transistor, the drain of  
5 the first switching transistor is coupled to the first  
6 output cascode transistor, and the gate of the first  
7 switching transistor receives the first control signal.

1 18. The charge pump as recited in claim 17 wherein:  
2 the first output mirror transistor has a drain coupled  
3 to the source of the first switching transistor  
4 and a source coupled to a voltage supply; and  
5 the first output cascode transistor has a source  
6 coupled to the drain of the first switching  
7 transistor and a drain coupled to the output  
8 node.

1 19. The charge pump as recited in claim 16 wherein the  
2 first and the second cascode current mirrors are a wide-  
3 swing cascode current mirror.

1 20. The charge pump as recited in claim 19 wherein the  
2 first cascode current mirror further comprises:  
3 a first input mirror transistor having a gate coupled  
4 to the first output mirror transistor and a  
5 source coupled to a voltage supply; and  
6 a first input cascode transistor having a gate coupled  
7 to the first output cascode transistor and a  
8 drain coupled to the gate of the first input  
9 mirror transistor and the reference current  
10 source.